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# Distribution of different forms of potassium and sulphur in soil of Bansdih block of Ballia district (U.P.)

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## Abstract
Two pedons were exposed in the Bankawa and Sheria village for study of depth wise distribution of fraction of potassium and sulphur. The $NH_4OAc$ extractable K content was found 548 kg/ha in surface horizon. The 0.01 M $CaCl_2$ extractable K was observed minimum value 126.6 kg/ha in pedon 1 in 135-150 cm depth of soil and showed decreasing trend with increasing depth in both pedon. EDTA extractable K was observed minimum value 278.2 kg/ha in depth of 135-150 cm of pedon 2.Water soluble extractable K was found maximum value 324.8 kg/ha in surface soil in pedon 2. The $HNO_3$ extractable K was observed maximum value 353.4 kg/ha in 135-150 cm of pedon 2. Mehlich III extractable K was found maximum 347.2 kg/ha in surface soil of pedon 2. $CaCl_2$ extractable S was found in maximum value 6.25 mg/kg in surface soil of pedon 1. Sulphur extractants *viz.* $HNO_3$ extractable S was found minimum value 1.25 mg/kg in 135-150 cm of pedon 1. KCl extractable S was observed maximum 6.62 mg/kg in surface soil of pedon 2. HCl extractable S was observed minimum value 5.53 mg/kg in 135-150 cm. Morgan's reagent extractable S was found greater value 7.2 mg/kg in surface soil of pedon 2, respectively. The soil pH of village was ranged from 6.4 to 7.7 in both pedon, EC of soils was found with no variation in horizon depth and it has ranged from 1.006 to 0.884 dSm-1. The amount organic carbon content in different depth was ranged from 0.24 % to 0.91% in both village and pedon.

**Key words-** soil depth, sulphur extractants, potassium extractants, organic carbon, EC and pH

## Introduction

Under intensive cultivation, easily available K is removed by different crops. This is followed by further release of exchangeable – K from, non-exchangeable form. The level of soil solution K depends upon equilibrium and kinetic reaction that occur between different forms of K, the soil moisture content and the concentration of bivalent cation in solution and phase (Sparks and Huang 1985). In soil, potassium exhibits in different form *viz*. water soluble, exchangeable, non-exchangeable and lattice K. These forms of potassium are in quasi equilibrium in the direction to replace it, dynamic equilibrium reactions occurring between the different forms of K have a profound effect on K nutrition. Different forms of potassium are present in soil in the order of their availability to plants and microbes as solution K, exchangeable K, non-exchangeable K and mineral K (Martin and sparks 1985). All these forms in dynamics equilibrium with each other that effect level of soil solution K for plants. Sulphur is a highly reactive elements present in many forms in soil and considered as the four major nutrients after nitrogen, phosphorous and zinc for agricultural crop in India (Srinivasrao *et al*. 2004). Sulphur containing amino acids like cystine, lysine and methionine are promotes nodulation in legume (Patel *at al*. 2013). The yield attributes of crops were greatly affected by sulphur application (Choudhary *et al*. 2019). In view of the above fact the study under go with the objective of depth wise distribution of available -S and K by different extractants in two village soils of Bansdih block.

### Materials and method

Ballia district lies between the parallel of $23^0$ 33' and $26^0$ 11' N latitude of $83^0$ 39' E longitude and 64 m of elevation. The mean annual rainfall ranges from 950-1150 mm. Study area Bansdih (Bankwa and Sheria village) block lies at $25^0$51' N latitude to $84^0$13' E longitude and 61m elevation from the sea level. For the study, soil samples were collected from well cultivated area two village *viz.* Bankwa and Sheria of Bansdih block. Sampling sites were carefully chosen talking in to consideration the ground cover, micro relief, degree of erosion, surface drainage, proximity to trees and all other factors likely to affect the soil in comparison with the normal type by open one pedon in each village. Soil sample were collected on 26 November, 2020 at the selected site when there were no crops standing in field and no rainfall occurred past 12-24 hours. Before the collection of sample, one pedon was opened in each village Bankawa and Sheria then collected soil samples from 0-15, 15-30, 30-45, 45-60, 60-75, 75-90, 90-105, 105-120, 120-135, 135-150 cm. About 2 kg of soil from each depth were taken in clean polythene bags separately by the help of *Khurpi*, scale and bucket. After well processing of soil sample were analysed for E.C. (Electrical conductivity) and pH by instrument method used 1:2.5 ratio of soil water suspension by using glass electrode (Chopra and Kanwar, 1999) method. Organic Carbon content of the soil was determined by Walkely's and Black's (1934) rapid titration method as described by Kanwar and Chopra (1998). Available potassium extractant as ammonium acetate extractable K by method described by Muhr *et al*. (1965), 0.01M Calcium chloride extractable K- Calcium chloride method described by Woodruff and Mclntosh (1960), EDTA Extractable K by EDTA method described by Haynes and Swift (1983), Water soluble K method described by Rouse and Bertramson, (1949), Nitric Acid ($HNO_3$) Extractable K method described by Wood and Deturk (1940), Mehlich - Extractable K by Mehlich method described Mehlich (1984), 1N Sodium chloride ($NaCl_2$) extractable K by Sodium Chloride method described by Scott *et al*. (1960) was used. Available Sulphur was analysed by different extractants as (1) $CaCl_2$ extractable – sulphur- was determined by Williams and Steinberg (1969) (2). Morgan's reagent extractable Sulphur-by method described by Chesnin and Yaien (1951) solution (3) KCl extractable sulphur- KCl extractant sulphur method described by Bloem *et al*. (2002) (4) 0.5M $NaHCO_3$ extractable Sulphur- $NaHCO_3$ extractable S method was described by Kilmar and Nearpao (1996). (5) HCl extractable Sulphur- HCl extractable sulphur method described by Little *et al.* (1958). Soil sample were analysed for Sulphur and potassium fraction by different method reported by different authors described by Jackson (1973) and Chhonkar *et al.* (2005).

## Results and discussion

### Soil pH, Soil E.C. and organic carbon content

Soil EC (table -1) from two different pedon of both village of Bankwa and Sheria Bansdih block soils on 0-15, 15-30, 30-45,45-60, 60-75,75-90, 90-105,105-120,120-135, 135-150 cm depth was ranged from 1.006 to 0.884 $dSm^{-1}$. Pedon–1 was showed 1.002 $dSm^{-1}$ at 0-15 cm and 0.996 $dSm^{-1}$ at 0-30 cm and 1.003 $dSm^{-1}$. The value varied between 1.006 to 0.884 $dSm^{-1}$ characteristics of the black alluviate soil. Similarly, soil pH (table-1) was ranged from 6.5 to 7.5 in both Pedon of village. The increasing range of pH towards slightly saline for surface soil (0-15) to lower depth (135-150 cm). Pedon-1 was showed 7.1 pH at 0-15 cm decrease with depth up to 6.5 (135-150 cm). Pedon – 2 range from 7.2 at 0-15 cm and it was increasing up to 135-150 cm value 6.8.The lower pH range was found at upper layer of Bankwa village soil than the 135-150 cm depth of soil due to presence of organic matter and possible higher activity of hydroxyl aluminum at higher pH level resulted in higher P adsorption (Sharma *et al.*2017).

Soil organic carbon content (table-1) of two different pedon of both village of Bankwa and Sheria was maximum 0.91% in surface soil 0-15 cm to 0.24% in sub-surface soil from 135-150 cm depth in pedon 1. Pedon-2 was showed 0.80 % at 0-30 cm after that it was decrease 0.24 % organic carbon content at 135-150 cm. Both pedon were showed high to low range of organic carbon content might due to accumulation of organic materials on surface as compared to subsurface.

Table 1- pH, EC and organic carbon content in different depth (cm) of Bankwa and Sharia village soil

| **Depth (cm)** | **Bankwa** | | | **Sharia** | | |
|---|---|---|---|---|---|---|
| | pH | EC ($dSm^{-1}$) | Organic carbon (%) | pH | EC ($dSm^{-1}$) | Organic carbon (%) |
| 0 – 15 | 7.1 | 1.002 | 0.91 | 7.2 | 0.993 | 0.73 |
| 15 – 30 | 7.4 | 1.003 | 0.80 | 6.6 | 0.996 | 0.75 |
| 30 – 45 | 7.3 | 1.001 | 0.64 | 6.8 | 0.992 | 0.65 |
| 45 – 60 | 7.2 | 1.004 | 0.51 | 7.3 | 1.002 | 0.55 |
| 60 – 75 | 6.3 | 0.994 | 0.58 | 6.6 | 0.998 | 0.65 |
| 75 – 90 | 7.1 | 1.002 | 0.50 | 6.8 | 0.997 | 0.68 |
| 90 – 105 | 7.4 | 1.003 | 0.41 | 7.3 | 1.002 | 0.63 |
| 105 – 120 | 7.5 | 1.006 | 0.41 | 6.4 | 0.996 | 0.57 |
| 120 – 135 | 6.3 | 0.884 | 0.30 | 7.4 | 1.004 | 0.62 |
| 135 – 150 | 6.5 | 0.996 | 0.24 | 6.8 | 1.006 | 0.26 |

## Vertical distribution of sulphur fraction (ppm) in Bankwa and Sheria village soil

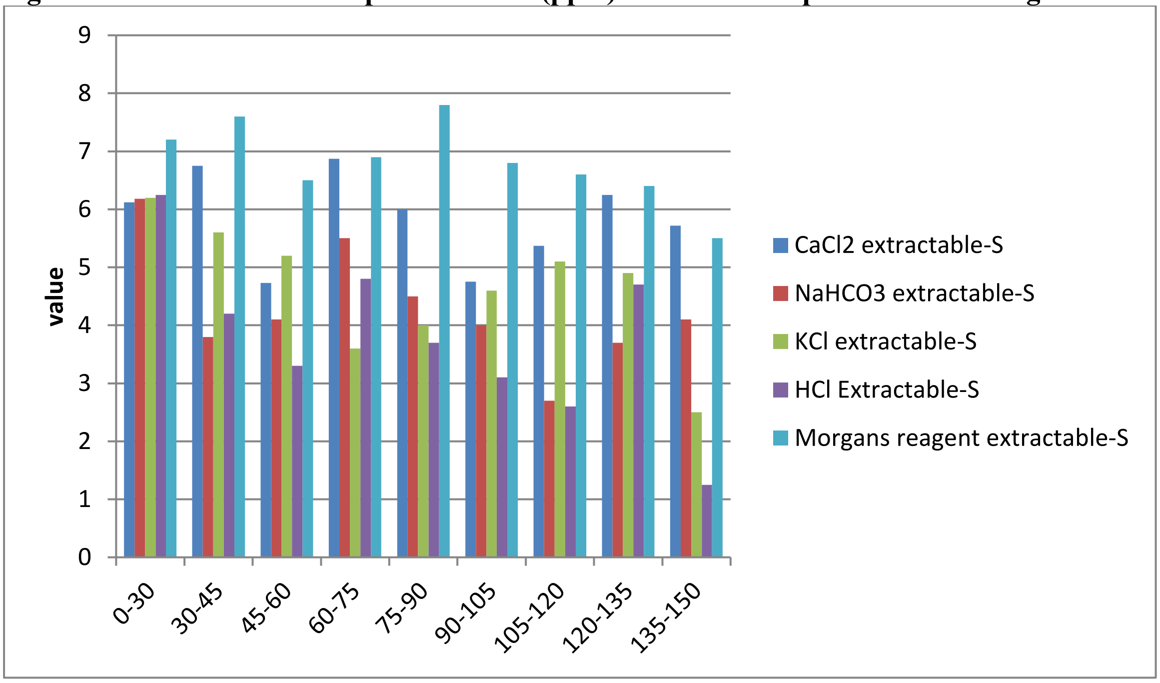
The amount of $CaCl_2$ extractable- S, 0.5 $NaHCO_3$ extractable- S, KCl extractable -S, HCl extractable -S and Margon's regeant extractable-S in Pedon-1 on 0-15, 15-30, 30-45,45-60 60-75,75-90, 90-105,105-120, 120-135, 135-150 cm soil depth (Table-3) $CaCl_2$ extractable- S, was decreased with increase in horizon soil depth Pedon-1 similarly, 0.5 $NaHCO_3$ extractable-S, HCl extractable-S, KCl extractable-S and Margon's regeant extractable-S were also decreased with increase in depth.

**Table 3 - sulphur fraction (ppm) in different depth of Bankwa village soil**

| Depth (cm) | $CaCl_2$ Extractable-S | $NaHCO_3$ Extractable- S | KCl Extractable- S | HCl Extractable- S | Morgan's reagent Extractable-S |
|---|---|---|---|---|---|
| 0-15 | 6.25 | 4.8 | 4.4 | 4.2 | 5.83 |
| 15-30 | 6.62 | 3.14 | 4.8 | 4.1 | 7.37 |
| 30-45 | 6.12 | 5.3 | 3.7 | 2.5 | 7.5 |
| 45-60 | 5.37 | 6.3 | 5.2 | 4.6 | 7.8 |
| 60-75 | 5.0 | 6.0 | 3.9 | 4.1 | 7.6 |
| 75-90 | 7.12 | 5.5 | 5.3 | 3 | 8.3 |
| 90-105 | 6.0 | 6.2 | 4.0 | 1.3 | 8 |
| 105-120 | 5.62 | 6.1 | 4.4 | 2.8 | 7.1 |
| 120-135 | 6.37 | 5.6 | 3.4 | 4 | 7 |
| 135-150 | 6.62 | 5.1 | 5.8 | 4.2 | 6.12 |

But, slightly increase at further depth. In pedon – 1 $CaCl_2$ extractable – S was measured 6.25 mg/kg at 0-15 cm soil depth 6.62 mg/kg at 135-150 cm depth, 0.5 $NaHCo_3$ extractable – S was measured 6.25 mg/kg at 0-15 cm soil depth to 5.37 mg/kg at 135-150 cm depth, KCL extractable – S was measured 4.4 mg/kg at 0-15 cm soil depth to 5.8 mg/kg at 135-150 cm depth to 6.62 mg/ kg at 135-150 cm depth on surface horizon. The similar finding have been given by Misal *et al.* (2017) and Azim *et al.* (2018). The amount of $CaCl_2$ extractable- S, 0.5 $NaHCO_3$ extractable- S, HCl extractable- S and Margon's regeant extractable- S were measured in pedon – 2 of 0-15, 15-30, 30-45, 45-60, 60-75, 75-90, 90-105, 105-120 and 120-135 and 135-150 cm soil depth (Figure- 4). $CaCl_2$ extractable- S was decreased with increase in horizons soil depth. Pedon-2 similarly, 0.5$NaHCO_3$ extractable- S, HCl extractable- S, KCl extractable- S and Margon's regeant extractable- S were also decreased with increase in depth. But, slightly increase at further depth. In pedon-2 $CaCl_2$ extractable- S, was measured 6.75 mg/kg at 15-30cm, soil depth to 1.25 mg/kg at 135-150 on surface horizon, 0.5 $NaHCO_3$ extractable – S was measured 3.8 mg/kg 15-30 cm, soil depth to 1.25 mg/kg at 135- 150 in surface horizon, KCl extractable – S was measured 5.6 mg/kg at 15-30cm, soil depth to 1.25 mg/kg at 135-150 in surface horizon, HCl extractable – S was measured 7.6 mg/kg at 15-30 cm, soil depth to 5.53 mg/kg at 135-150 in surface horizon and Margon's regeant extractable – S was measured 7.2 mg/kg at 0-15, soil depth to 5.5 mg/kg at 135-150 in surface horizons, the amount of different forms of S decreased with depth. The similar finding have been given by Misal *et al.* (2017) and Azim *et al.* (2018) also. The similar findings have been given by Pal *et al.* (2007) also.

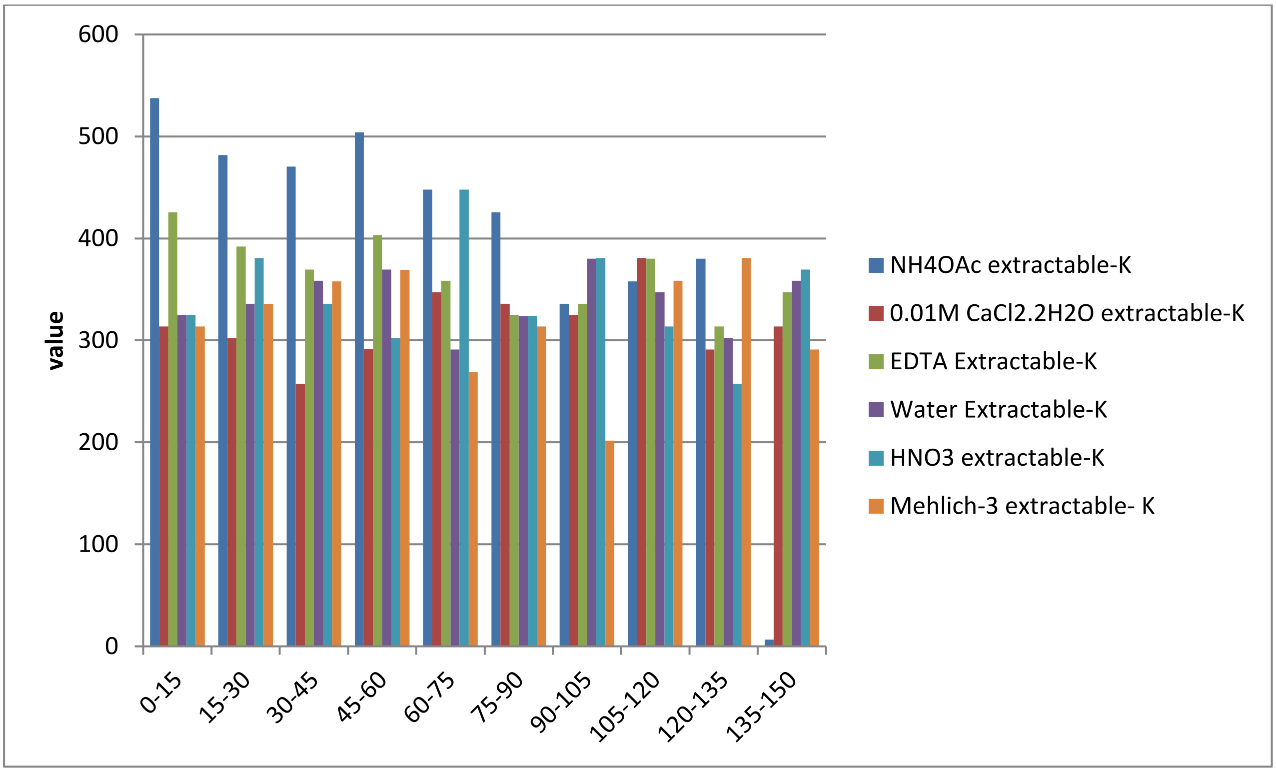
**Figuar 4 – Distribution of sulphur fraction (ppm) in different depth of Sheria village soil**




## Distribution of potassium (kg/ha) in Bankwa and Sheria village soil

The amount of $NH_4OAc$ extractable– K, 0.01M $CaCl_2$. $2H_2O$ extractable–K, $HNO_3$ extractable and Melich-III extractable – K, were measured in Pedon-1 at 0-15, 15-30, 30-45, 45-60 60-75,75-90, 90-105,105-120, 120-135 and 135-150 horizons depth (Figure 5). Available potassium was decreased with increased in horizons depth at Pedon-1, similarly, 0.01M $CaCl_2$ extractable K were also decreased with increase in depth. But, EDTA extractable – K, Water soluble- K and Melich-III extractable K were indicating a increasing trend with increase in depth at Pedon– 1. Available potassium was measured 537.6 kg/ha at 0-15cm soil depth to 356 kg/ha at 135-150 cm depth on surface horizon, 0.01M $CaCl_2$ extractable K, 313.6 kg/ha in 0-15 cm soil depth to 131.6 kg/ha at 135-150 cm in surface horizon, EDTA extractable – K, 425.6 kg/ha in 0-15 cm soil depth to 347.2 kg/ha at 135-150 cm in surface horizon, Water soluble K, 324.8 kg/ha in 0-15 cm soil depth to 358.4 kg/ha at 135 – 150 cm in surface horizons, $HNO_3$ extractable K, 324.8 kg/ha 0-15 cm

**Figure 5. Distribution of potassium fractions, (kg/ha) in different depth of Bankwa village soil**




soil depth to 369.6 kg/ha at 135-150 cm in surface horizons and Melich-III extractable K, 313.6 kg/ha 0-15 cm soil depth to 291.2 kg/ha at 135-150 cm in surface horizon. So that surface soil contain greater amount of $NH_4OAc$ K then the other extractants, the similar finding have been given bySingh *et al.(*2019), Anupama *et al.* (2018) and Mali *et al.* (2016) also.

### Distribution of forms of potassium (kg/ha) in Sheria village soil

The amount of $NH_4OAc$ extractable-K, 0.01M $CaCl_2$ extractable K, EDTA extractable K, $HNO_3$ extractable K and Mechlich-III extractable K were measured at Pedon-2 in 0-30cm, 30-45, 45-60, 60-75,75-90, 90-115,115-137,137-155 cm (Figure 6). $NH_4OAc$ was decreased with increase in horizons depth at pedon-2 Similarly, 0.01M $CaCl_2$ extractable K, $HNO_3$ extractable K, and Mechlich-III were also decreased with increase in horizons depth, But EDTA extractable K and Mechlich-III extractable K, decreased with increase in depth but slightly increase at further depth. In Pedon-2. $NH_4OAc$ K, was measured 280 kg/ha at 0-15 cm soil depth to 291.2 kg /ha at 135-150 cm on surface horizons, EDTA extractable K, 434.2 kg/ha 0-15 cm soil depth to 278 kg/ha at 135-150 cm in surface horizons, water soluble K, 299.2kg/ha 0-15 cm soil depth to 324.8 kg/ha at 135-150 cm in surface horizons, $HNO_3$ extractable K, 313.6 kg/ha at 0-15 cm soil depth to 353.4 kg/ha at 135-150 cm in surface horizons and Mechlich-III extractable K, 347.2 kg/ha at 0-15 cm soil depth to 262.2 kg/ha at 135-150 cm in surface horizons. Therefore, $NH_4OAc$ extractant have been appeared to release greater amount of K then the other extractants it might be due to solubility effect, the similar finding have been given by Anupama *et al.* (2018), Mali *et al*. (2016) and Singh *et al.* (2019) also.

**Figure 5. Distribution of potassium fractions, (kg/ha) in different depth of Bankwa village soil**

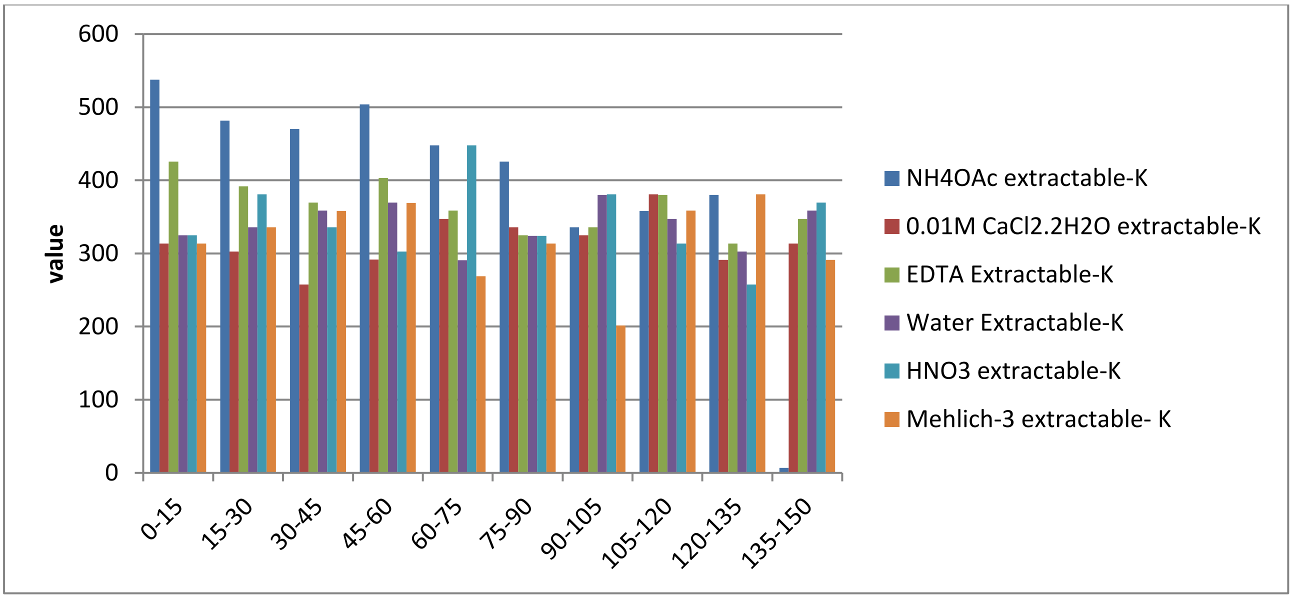
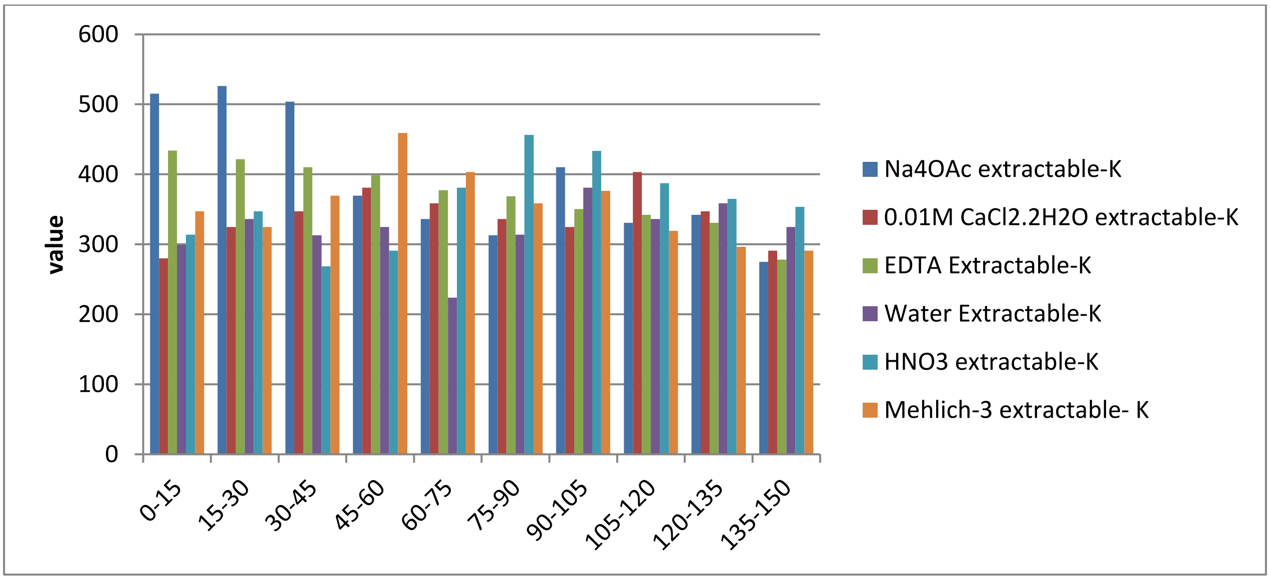



**Figure 6. Distribution of potassium fraction (kg/ha) in different soil depth of Sheria village soil**




## Conclusion

Soil pH value was found minute decreased with increased soil depth and it has ranged from 6.4 to 7.7 in both pedon of village, soil EC have no variation in depth with ranged from 1.006 to 0.884 dSm-1. The maximum organic carbon content was found in surface soil and decreased with increase in depth with ranging from 0.24% to 0.91%. The $NH_4OAc$ extractant for available K and $CaCl_2$ extractant for available sulphur was found suitable among the extractant.

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